

coil 31 and coil 32 form a top coil pair and coil 33 and coil 34 form a bottom coil pair. Preferably, the coil pairs overlap such that mutual inductance between coil 32 and coil 33 and between coil 31 and coil 34 is low. Most preferably, the amount of overlap can be selected so as to achieve approximately zero mutual inductance. Additional coil pairs can be added and/or the coil pair(s) can be rotated with respect to the central axis of the cylinder formed by loops 28, 29, and 30.

Amend.

Page 8, lines 28-29 and page 9, lines 1-5 (amended):

Figure 6 shows an embodiment of the subject invention incorporating side by side loops. Loops 37 and 40 form one loop pair and loops 38 and 39 form another. Preferably the amount of overlap of side by side loop pairs is chosen so that the mutual inductance of the loops is low, and, more preferably, the amount of overlap is chosen so that the mutual inductance is approximately zero. Additional loops can be added to one or more side by side pairs and/or additional side by side pairs can be added. Again, the side by side pairs can be rotated with respect to the central axis of the cylinder formed by loops 34, 35, and 36.

Page 9, lines 17-24 (amended):

With respect to the embodiments shown in Figure 7 and Figure 9A, Figure 12 illustrates a specific embodiment of a capacitive network which can be used to minimize or cancel mutual inductance between the single solenoid and the crossed ellipse. Referring to Figure 12, 10A and 10A' represent the contacts for ellipse 10B and are analogous to contacts 14A and 14A' for ellipse 14B of Figure 9A; 12A and 12A' represent the contacts for loop 12B and are analogous to contacts 17A and 17A' for loop 17B of Figure 9A; and 11A and 11A' represent the contacts for ellipse 11B and are analogous to contacts 15A and 15A' for ellipse 15B of Figure 9A. C1, C2, C3, and C4 are four capacitive elements of the capacitive network shown in Figure 12.

Amend.

Page 9, lines 25-29, Page 10, lines 1-23, and Page 11, lines 1-9 (amended):

In a specific embodiment, the crossed ellipse/opposite rotating configuration shown in Figure

8 can be simplified by the superposition of the opposite rotating mode on the crossed ellipse conductors as shown in Figure 15. In a specific embodiment, the two loops that form the opposite rotating mode in Figure 8 can be removed, and the opposite rotating mode can be superimposed onto the crossed ellipse. In this embodiment, the crossed ellipse configuration can support two linear orthogonal modes, one for each loop, and a third mode which represents the opposite rotating mode. Alternatively, the crossed ellipse configuration can support two linear orthogonal modes, each a superposition of individual modes associated with each of the two coils. The opposite rotating mode can be isolated from the two linear orthogonal modes due to zero mutual inductance. Referring to Figures 8, 15B, and 15C, loop 15B can produce a first linear mode 100 of the crossed ellipse, and loop 14B can produce a second linear mode 101 of the crossed ellipse which is orthogonal to the first mode. The opposite rotating mode 103 of the crossed ellipse is shown in Figure 15C where the crossed ellipses have been broken apart in a manner to emphasize the currents for producing the opposite rotating mode 103. Reference points 98 and 99 shown on Figures 15A, 15B, and 15C illustrate points at which the current can change directions to produce two linear orthogonal modes or the opposite rotating mode. Coupling to the structure can be achieved through capacitive or inductive methods. If desired, the opposite rotating mode can be produced on a second crossed ellipse coil pair aligned with the first coil pair.

Referring to the embodiment of the subject invention shown in Figure 9A, coil 17B can act as a solenoid around the center of the region of interest. Coils 14B and 15B can form crossed ellipse coils, and coils 16B and 18B can form an opposite rotating coil centered on coil 17B. The opposite rotating coil can be isolated via symmetry from coils 17B, 14B, and 15B. 14A, 15A, 16A, 17A, and 18A show the contacts for the various coils. Coils 14B and 15B can be isolated from one another by, for example, having their axes perpendicular to each other. In this arrangement, Coil 17B can have strong mutual inductance with both coils 14B and 15B. This inductance can be isolated by using one or more of various techniques known to those skilled in the art. The opposite rotating coil can have a zero flux in the center and improve the homogeneity of the coverage by producing fields away from the center. Advantageously, the embodiment of Figure 9A can produce excellent

homogeneity down the axis of the cylinder.

In another embodiment of the subject invention, as shown in Figure 9B, coil pair 16B and 18B can be modified so as to produce an Alderman-Grant (Alderman, D.W. and Grant, D.M., *Jo. Magnetic Resonance* 36:447 [1979]) type of coil, such that coil 17B is isolated from the Alderman-Grant coil due to the fields of the Alderman-Grant being perpendicular to the fields of coil 17B. Such an Alderman-Grant coil can be achieved by adding a pair of conductors 30 and 31 to connect coils 16B and 18B such that conductors 30 and 31 carry the same magnitude current in opposite directions. The currents flowing in conductors 30 and 31 are split when the currents enter a coil, with one-half the magnitude of the current flowing in each half of the coil. For example, current flowing from conductor 30 flows one-half in each half of coil 18B to conductor 31, and current flowing from conductor 31 flows one-half in each half of coil 16B to conductor 30. 14A, 15A, and 17A show the contacts for the various coils, and 30A shows the contacts for the Alderman-Grant coil. In this embodiment, coils 17B and the Alderman-Grant coil are isolated due to their perpendicular fields and coils 14B and 15B are isolated from one another by, for example, having their axes perpendicular to each other. Coil 17B shares inductance and sample resistance with coils 14B and 15B, and the Alderman-Grant coil shares inductance and resistance with coil 14B and 15B.

Page 11, lines 15-23 (amended):

Figures 10 and 11 illustrate switching networks which can be utilized with respect to the three solenoid embodiment, for implementing a method to allow the opposite rotation of the loop currents in either a series or parallel fashion. Figure 10 shows a switching network for allowing the outer two coils to have currents which either rotate in the same direction or in opposite directions. Referring to Figure 10, 1A', 2A', and 3A' connect to the top contacts of loops 1B, 2B, and 3B of Figure 1, while 1A, 2A, and 3A connect to the bottom contacts. By closing switches 50 and 53, loops 1B and 3B can be driven in the same rotation direction. By closing switches 51 and 52 and opening switches 50 and 53, loops 1B and 3B can be driven in opposite rotation direction. Analogously, 1A', 2A', and 3A' of Figure 11 can connect to the top contacts of loops 4B, 5B, and

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6B (4A', 5A', and 6A', respectively) of Figure 2, while 1A, 2A, and 3A of Figure 11 connect to the bottom contacts (4A, 5A, and 6A, respectively). Analogously, 1A', 2A', and 3A' of Figure 11 can connect to the top contacts of loops 7B, 8B, and 9B (7A', 8A', and 9A', respectively) of Figure 3, while 1A, 2A, and 3A, of Figure 11 connect to the bottom contacts (7A, 8A, and 9A, respectively).

Amend.
\\ Page 13, lines 5-20 (amended):

Referring to Figure 13, five loops oriented co-axially to one another, with bilateral symmetry around the center loop A, B, C, D, and E, are shown. Bilateral symmetry means any loop on one side of the center loop is the same distance to the center loop as a similar loop on the other side of the center loop. These five coaxial loops can be used to produce five current patterns that have negligible mutual inductance between each pair of patterns in a region of interest. Three of these current patterns have even symmetry, while two have odd symmetry around the center loop. The odd symmetry patterns are required to have zero current in the center loop, since odd symmetry of currents means that a loop on one side of center has opposite rotating current to the similar loop on the other side of center. Even symmetry of current requires a loop on one side of center to have equal current in the same direction to a similar loop on the other side of center. All even symmetry patterns will inherently have zero mutual inductance with all odd symmetry patterns. Figures 14A and 14B show example field patterns down the central axis of the loops which can produced by certain current combinations for the loop configuration shown in Figure 13. The field patterns shown in Figures 14A and 14B illustrate how negligible mutual inductance can be produced between various field patterns.

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\\ Page 14, lines 6-16 (amended):

Referring to Figure 16A, an external coil is shown at X_0 which can produce a non-uniform B-field at the position of a coil pair configuration, one coil at X_1 and a second coil at X_2 . The coil at X_1 can have a radius R_1 and current I_1 while the coil at X_2 can have a radius R_2 and a current I_2 . The coil pair can be adjusted such that the net electromagnetic force (EMF) caused by flux through